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More than Just Eye-Catching: Evaluating Graphic Quality in Middle School English Language Learners' Science Textbooks

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Abstract

Second language (L2) instructors frequently use visual stimuli to support learning, particularly content-specific learning; however, not all visuals are effective in supporting curriculum. Previous research has demonstrated that while graphics may make texts visually appealing, middle grade students, even native English speakers, are not consistently skilled in interpreting science diagrams and integrating textual and visual information simultaneously. This study used the Graphics Analysis Protocol (GAP; Slough & McTigue, 2013), which has been used to assess U.S. science textbooks to evaluate how well graphics in scientific readings support both content knowledge and second language acquisition. Our sample included 118 graphics from 54 readings used to teach science in English to 7th and 8th grade English language learners (ELL) in Qatar. Our findings indicate that not only does poor integration of text and graphics fail to support student learning, but it also may hinder overall reading comprehension. Results suggest that individuals selecting instructional materials for ELL need to evaluate visuals as part of the selection process, particularly with technical classes such as science. Recommendations for practitioners are provided.

A photograph of a car with a raised hood accompanies a science lesson on energy (see Figure 1). Native speakers may understand the purpose of including the visual: A car's internal combustion engine represents a concrete example of energy changing form. If an English language learner (ELL) were to read the same passage and see the same photograph, however, would he or she interpret the visual in the same manner? Would this picture help the student acquire both the targeted content knowledge and English skills, or would its presence distract and confuse?

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Figure 1. Representative example of graphic from lesson on energy.
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Instructors frequently use visual stimuli such as pictures, graphs, and charts, to support second language (L2) development; however, not all visuals are effective. While pre-service teachers typically learn to use visuals as one of the first interventions for struggling English language learners (e.g., Texas Education Agency, 2011), little guidance is provided on how to select and assess graphics. Cunningsworth (1984), for example, argued that the primary objective of visuals should be to support content material for ELLs, but he provided no means for assessing this quality in instructional graphics.

The present exploratory study evaluates English language science texts used in Qatari middle schools. As part of recent rapid economic and social development, Qatar has been devoting considerable resources to evaluating and reforming its educational system. After a 2002 analysis of the education system, *Education for a New Era* (Law Decree No. 37; Khedr, 2013) was enacted, initiating the development of national curriculum standards that emphasized critical thinking. This reform also instigated math and science instruction conducted in English (Brewer et al., 2007). A subsequent policy shift in 2012 resulted in a change back to Arabic as the primary medium of instruction for math and science with a mandate that students also achieve basic literacy with English technical language used in the study of math and science (Paschyn, 2013). We used a modified version of the Graphics Analysis Protocol (GAP; Slough & McTigue, 2013) to evaluate English language materials being used in Qatar. In addition to developing an appropriate graphical assessment tool for ELLs and evaluating a particular set of texts, our overarching goal was to make recommendations for how ELL educators can select effective texts and support their students' second language acquisition.

Theoretical Framework

Consistent with current research (Norman, 2012), we interchangeably use the terms *graphics* and *visuals* to describe any non-text presentation of content information.

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Consistent with current research, we interchangeably use the terms *graphics* and *visuals* to describe any non-text presentation of content information. While a graphic may contain some text, such as a label on a larger diagram, words are not the primary mode of information transfer. Based on the work of Norman (2012), we define graphics to include photographs, drawings, diagrams, flow charts, maps, tables, graphs, and any combination of these classifications.

To date, while researchers have assessed the value of graphics in U.S. science textbooks and made recommendations to ensure these texts are not only visually appealing, but also reinforce curriculum objectives (see Slough, McTigue, Kim, & Jennings, 2010), little research has focused on quantifying the role visuals play in helping ELLs master both language and content. This dearth is surprising given the importance of visuals in scaffolding the content and language learning for ELL (Harmon, Wood, Hedrick, Vintinner, & Willeford, 2009).

Given the *cognitive load* (Cummins, 1979; Sweller, Chandler, Tierney, & Cooper, 1990) for ELLs who are reading science in English, visuals should reduce, rather than add to, task complexity. Unfortunately, previous work has demonstrated that diagram designs, which are useful for monolingual adults, may not directly transfer in utility to monolingual young learners (McTigue, 2009); therefore, a graphic's utility depends greatly on the target audience. Based on such findings, it is logical to assume that there may not be direct transfer for an effective graphic from monolingual students to ELLs.

Rationale for Graphics in Science Texts

Visual representations of information help students move vocabulary and content from working memory to long term memory. According to Banikowski and Mehring (1999), adolescents can store five to seven *bits* of discrete information in working memory. Classes aiming to teach both language skills and content knowledge often provide students more information than they can convert from working to long term memory. Banikowski and Mehring suggested two methods for transferring information into long term memory: repeating information and making associations. Well designed visuals accomplish both strategies.

Similarly, Dual Coding Theory (DCT) posits that visual stimuli, such as the graphics in a textbook, provide students with a second, nonverbal mode to understand and encode content (Clark & Paivio, 1991). When a text provides students with both verbal and nonverbal (i.e., visual) representations of information, they are more likely to remember the content because there are two routes to encode and retrieve the same information. This is especially true of science texts, which frequently describe complex processes. For example, while a text can explain the water cycle in words, this cyclical information may be easier for a student to understand in the format of a diagram that is not limited by linear constraints of texts. In short, while learners benefit from any type of information being presented in multiple formats, specific types of information are simply better communicated in pictures.

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Possible Challenges of Graphics

According to Sipe (1998), when confronted with graphics, students must negotiate a process of *transmediation*, the transformation of information from one sign system (text) to another (visuals). When not properly integrated with the text, graphics waste cognitive energy as students struggle to find the relationship between the text and graphics. It is important to consider that many ELLs' first language is already composed of a different sign system than their English language textbooks; therefore, if teachers and administrators do not consider the quality of graphics when selecting readings, their students may be required to conduct transmediation multiple times – between first language and English, as well as texts and graphics – wasting cognitive energy. Additionally, Sipe proposed that readers use transmediation to fill "in the unwritten work or the 'gaps' in his or her own way" (p. 99). If graphics are not supported by textual content, students may come to personal, perhaps incorrect, understandings of a visual's purpose.

Along with the challenges of transmediation, recent research has demonstrated that students struggle to understand graphical concepts. According to Roberts et al. (2013), while early elementary students are capable of recognizing the more salient relationships between pictures and texts, both younger and older students often lack the ability to distinguish important graphical information. As a result, learners require direct instruction to understand that some graphics provide information not present in the text. Similarly, McTigue and Flowers' (2011) qualitative study concluded that while graphics may make science texts more visually appealing, elementary and middle school monolingual students are not skilled in either interpreting science diagrams or integrating visual information with text. For example, students frequently misinterpreted the arrows in a diagram of the water cycle as pointing to an object rather than representing the flow of water, and this misinterpretation impacted overall reading comprehension.

Additionally, students often disregard visuals as unimportant and devote more attention to decoding the text. Previous findings with eye-movement tracking software indicate that students need incentives to examine graphics while reading science texts, as middle grade students spent only 6% of their reading time examining graphics in science texts, even when graphics presented critical information for reading comprehension (Hannus & Hyönä, 1999). As a result, Hannus and Hyönä recommended that well designed texts should direct readers to graphics at relevant intervals. Ho, Tsai, Wang, and Tsai's (2014) recent results using similar eye-tracking methods correspond with Hannus and Hyönä. These researchers established that readers with minimal background knowledge spent less time examining graphics than their more knowledgeable peers, indicating students need textual reminders to examine graphical content.

Even if students do look at visuals in texts, these visuals may lead to confusion rather than comprehension. Mayer and Moreno (2003) argued that even with older, more skilled readers, multimedia (text + visuals) learning can lead to *incidental processing* when students waste cognitive energy on nonessential information. Work

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by Wade (1992) regarding *seductive details* also indicated that interesting but irrelevant information within texts can detract from students' overall comprehension. While her work was textual in nature, the impact of distraction would likely be similar regardless of the input source. Purposeful graphics must therefore support content knowledge acquisition rather than distract learners. It is especially critical that superfluous information not distract ELLs who are using context to fill in both knowledge and language gaps.

Graphics and Second Language Acquisition

ELL instructors are acutely aware of the value of visuals in instructional materials. For instance, even though a recent teacher survey evaluating an Iranian English textbook did not directly inquire about visual aids, the topic emerged repeatedly in the teachers' open-ended responses (Zohrabi, Sabouri, & Behroozian, 2012). The majority of respondents mentioned that the learning process could be enhanced through the use of supplementary visual aids. When asked about the constraints of the current texts, 35% mentioned the lack of visual aids and 60% identified a lack of interesting and attractive pictures.

To date, many evaluations of graphics for ELLs only consider affective impact and not their potential contribution to content knowledge and language acquisition. For example, while Nahrkhalaji's (2012) evaluation protocol of Iranian English language textbooks appraises the illustrations in the textbook, Nahrkhalaji argued that these visuals were important because they help "create a motivational atmosphere" and focused the evaluation on how "graphic devices… and page layouts …increase[d] the attractiveness of the materials" (p. 187). As noted, while supporting student motivation is critical, learning theory and empirical results demonstrate that graphics have the potential to do much more to help ELLs' academic progress.

Graphics can perform many functions, including providing comprehensible input and making complex ideas more accessible and language more memorable (McCloskey, 2005). Vocabulary development in particular is one of the strongest predictors of ELLs' academic performance (Fraga, Harmon, Wood, & Buckelew-Martin, 2011; Saville-Troike, 1984). Graphics provide a visual dictionary for ELLs, allowing them to infer word meaning without breaking their engagement from the reading activity at hand. Additionally, learning vocabulary requires multiple exposures in a variety of contexts (Harmon et al., 2009). Well-designed visuals can provide additional opportunities for ELL students to develop vocabulary.

The purpose of this study was to examine graphics in science texts to provide strategies for selecting the best textbook available and make recommendations for ELL instructors restricted to specific curriculum materials. Based upon this goal and existing literature, we developed the following research questions:

1. What are the characteristics of the graphics in Qatar's English language science texts?

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2. How and to what degree are graphics integrated within the text in Qatar's English language science texts?

Method

Instrument

The Graphics Analysis Protocol (GAP) instrument and methodology was initially piloted and developed by McTigue, Carlin, and Coleman (2007). These researchers merged and updated existing coding systems by Moline (1995); Hunter, Crismore, and Pearson (1997); Vekiri (2002); and Pappas (2006). The purpose of the GAP was to capture the critical characteristics of more modern graphics' representations, particularly in U.S. science tradebooks and textbooks. Using science texts awarded the distinction of "Outstanding Science Trade Book" in their year of publication by the National Science Teachers' Association, the authors quantified the (a) variety of graphics, (b) their function, and (c) the extent that the text and the graphics were integrated. For example, texts with high levels of integration had embedded directives for when the reader should look at the graphical representation (e.g., *in the diagram above note*…). Of particular interest was the analysis of the function of the graphics: some graphics were merely decorative while others added essential information to the text.

For the purpose of this study, the original GAP was adjusted in three ways to reflect ELLs' need to develop content vocabulary. First, a separate category, *glossary labels*, was added to the GAP. *Glossary labels* are graphics in which the parts of a system, object, or organism are denoted by arrows and words. The original GAP coded for glossary labels within a larger category. Thereby, a text with high percentages of glossary labels would not meet the profile of high quality illustrated text; however, because students learning science in a second language may require additional vocabulary terms in order to comprehend readings and discuss content, glossary labels are especially functional. For instance, teachers would likely assume that a native-speaking student studying plants would already have mastered basic plant parts such as stem, leaf, trunk, and branch; however, instructors cannot assume the same for L2 learners. Therefore, the presence of glossary labels would be considered a hallmark of appropriate graphic support for both content-area knowledge and L2 development.

The second revision of the GAP was not in the instrument, but in the interpretation of the *semantic relations* category. This category coded the function of the graphics on a continuum of complexity with a score of *Level 1* describing a predominately decorative graphic, *Level 2* describing a graphic which contained information that was redundant with the text, *Level 3* describing a graphic which provided additional information beyond the text (i.e., an extension), and *Level 4* describing a graphic which provided an organizational structure for information in the text (e.g., a flow chart). While higher quality texts were associated with containing elements of more complex graphics, for ELLs the importance of visually representing the information in the text was heightened, thus elevating the importance of the *Level 2* scores.

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As a third revision, not all sections of the original GAP instrument were used in this study due to the nature of the research questions. For instance, the original GAP identified whether graphics were in color or black and white. As this quality would not impact students' language acquisition and would rely heavily upon the printing facilities at individual schools, however, we chose not to utilize this category.

The GAP included two types of descriptors: *individual graphics* and *graphic integration*. The individual graphics descriptors (Table 1) provided three types of information: (a) graphic classification, (b) presence of glossary labels, and (c) systematicity of the image (i.e., were science concepts contextualized?). The graphic integration descriptors (Table 2) provided information regarding the level of connection between texts and graphics. Four types of information were included: (a) contiguity between text and graphic, (b) text references to the graphic, (c) quality of graphic captions, and (d) semantic relationship between the text and graphic.

Table 1. *GAP Individual Graphics Descriptors*

Descriptor	**Scale**	**Rubric Descriptions**
Graphic Classification	Categorical	Photograph; Naturalistic Drawing; Stylized Drawing; Flow Chart; Cut-away / Cross Section; Tables; or Hybrids (Two or more categories mentioned)
Glossary Labels*	Yes/No	Describes whether or not graphic had labels to define parts of the image
Systematicity	Ordinal	Low = the graphic depicts an isolated unit, not integrated into a larger system Medium = the graphic depicts some aspect of a system High = the graphic would help viewers build a mental model of a system

Note. More information about the development and use of the original Graphics Analysis Protocol can be found in Slough and McTigue (2013).
* = Category added to original GAP for L2 evaluation.

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Table 2. *GAP Graphic Integration Descriptors*

Descriptor	Scale and Range	Rubric Descriptions
Contiguity	5 point ordinal scale	Describes how well the text and graphic are integrated on the page
Text Reference	Yes/No	Describes whether or not the text refers to the graphic
Quality of Captions	4 point ordinal scale	Describes whether or not the graphic has captions and, if so, how the caption engages the reader 1 = No captions 2 = Caption identifies the target of the graphic, but does not provide details 3 = Caption provides a description and associates the graphic to the main text 4 = Caption actively engages viewer (e.g., asks a question, poses a task)
Semantic Relations	Categorical: Decorative, Representational, Organizational, or Connection	Decorative = adds affective component Representational = directly shows what was in the text (adds concreteness) Organizational = add coherence by putting the information within a greater scheme Connection = represents the information in the text and adds new information
Level of Connection	3 point ordinal scale *Only evaluated if graphic semantic relation is* Connection	1 = Information provided by graphic would be easy to interpret and would clearly link to the text 2 = Information provided by graphic would be relatively easy to interpret, but the link between the text and the new information would be less concrete 3 = Information provided by graphic would add new information, but the image would require background knowledge and scrutiny to derive its meaning

Note. More information about the development and use of the original Graphics Analysis Protocol can be found in Slough and McTigue (2013).

Sample

We analyzed a semester's reading load from two sets of English language science texts at both the seventh and eighth grade levels (four semesters total). Both sets consisted of short lessons aimed at simultaneously supporting seventh and eighth graders' science curriculum knowledge and English language acquisition. It is important to acknowledge that the texts used to support learning of science in English in Qatar were not typical science textbook series created by international publishers. They were collections of short readings created by the education authority to introduce English

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terms and conceptual explanations corresponding to the scientific topics covered in the Arabic language textbooks series.

The first set of texts, referred to here as *Scientific English* (SE), included topics in life and physical sciences and was designed for use in a weekly one-hour course designed to build fluency in English science terminology. These texts were collected and published in book form, with each book covering a semester's worth of lessons. At the beginning of each lesson, an image of an interactive SMARTBoard with graphics for the day's lesson appeared followed by a casual conversation between a teacher and student that presented the content. Our sample of *Scientific English* texts comprised the seventh and eighth grade's first semester lessons. For each grade there were 15 one-page lessons, each with two to three pages of review activities. At the suggestion of the GAP developers (E. McTigue, Personal Communication, May 6, 2013), we decided to consider only graphics used for instruction and content clarification in order to avoid artificial deflation of statistics; therefore, we did not review graphics in the activities sections. A total of 58 images were analyzed from the seventh and eighth grade lessons in this series.

The second series of texts, referred to as *Science Related Readings* (SRR), was designed and distributed by the education authority for use in the regular science courses, which were taught predominately in Arabic, but which were also supposed to support the ability to read science texts in English. These texts were presented to teachers as individual lessons, ranging from three-to-five typed pages of text with an additional three-to-five pages of activities. For the present study, we only analyzed graphics used in the lesson for instructional purpose. There were 60 graphics analyzed from the seventh and eighth grade SRR lessons. Thus, a total of 118 graphics from the SE and SRR texts used in the two grades were analyzed.

Procedure

To individually analyze graphics and record data, a rubric utilizing the descriptors in Tables 1 and 2 was created. Initially, the first author was trained by one of the developers of the original GAP to ensure consistency in graphic evaluation and comparability with other studies using the protocol (e.g., Slough et al., 2010). The first and second authors then coded and discussed examples of graphics used in previous research with the GAP to create a rubric specific to the present study. Next, exemplars for each rubric category were developed. Third, the first and second authors then discussed and coded a subset from each ELL science text until inter-rater reliability was established. Finally, the first author coded the remaining ELL science texts independently but marked ambiguous items. Ambiguous items were discussed by both authors until consensus was reached.

Results

Individual Graphics Descriptors

We examined the individual graphics descriptors to answer our first research question: *What are the characteristics of the graphics in Qatar's English language*

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science texts? The majority of the graphics (70%) in the SE texts were stylized drawings, meaning line drawings that contained elements of realism, such as in a comic strip. The SRR graphics, by contrast, were largely photographs (48%), although stylized drawings were also represented (31%, see Table 3).

Table 3. *Graphics Classifications*

	Photograph	Naturalistic Drawing	Stylized Drawing	Flow chart – Cycle	Flow chart– Sequence	Cut-away/ Cross section	Table	Hybrid
SE, Grade 7	6.9 %	6.9%	68.9%	0%	17.2%	6.9%	0%	13.8%
SE, Grade 8	12.9%	12.9%	70.9%	6.5%	6.5%	12.9%	6.5%	58%
SRR, Grade 7	51.3%	10.2%	30.8%	0%	0%	10.2%	0%	5.1%
SRR, Grade 8	42.1%	5.2%	31.6%	5.2%	5.2%	15.8%	5.2%	21%

Note. Graphics may be classified under more than one category, so percentages may not equal 100%.

Table 4 details the inclusion of glossary labels and the graphics' systematicity scores. Glossary labels, which aid in interpretation and integration, were present in less than half of the graphics. The graphics also received low systematicity scores, meaning they represented a single idea rather than being contextualized as a part of a system. For example, a photo of a single cell would receive a lower systematicity score than a diagram displaying the multiple steps in cell division. Ideally a text would contain graphics which give details about a single concept and put the concepts in a greater context of a system.

Table 4. *Glossary Labels and Systematicity Scores*

	Glossary Labels	**Mean Systematicity[a]**
SE, Grade 7	31%	1.45 (0.74)
SE, Grade 8	42%	1.32 (0.54)
SRR, Grade 7	15%	1.2 (0.52)
SRR, Grade 8	11%	1.21 (0.38)

Note. Standard deviations displayed in parentheses next to mean.
[a] Maximum possible score of 4.

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Integration Descriptors. The integration descriptors provided information to answer our second research question: *How and to what degree are graphics integrated with the text in Qatar's English language science texts?* The assessment of integration involved five properties: contiguity of text and graphic, reference to graphic in text, quality of captions, semantic relation between text and graphic, and the degree of connection when the semantic relation was categorized as both representing information in the text and adding information to it. Regarding contiguity, more than 91% of all graphics appeared on the same page as the written information; however, while most graphics were near relevant written information, very few text references or meaningful captions existed (Table 5).

Table 5. *Text References to Graphics and Quality of Caption Scores*

	Graphics Referenced in Text	**Captions' Mean**
SE, Grade 7	69%	2.00 (0.6)
SE, Grade 8	35%	1.90 (0.7)
SRR, Grade 7	23%	1.41 (0.7)
SRR, Grade 8	5%	1.21 (0.62)

Note. Standard deviations displayed in parentheses next to mean.

With respect to mentioning graphics in the text, the SE texts had more references than SRR texts due to the layout of the lessons. The SE series was more modern in nature and contained an image of an interactive SMARTBoard and a casual conversation between a cartoon student and teacher (Figure 2). Often, the teacher would instruct the students to look at the board, providing the reference necessary for this analysis; however, rarely did the text provide explicit descriptions of how the information in the graphic overlapped with the text.

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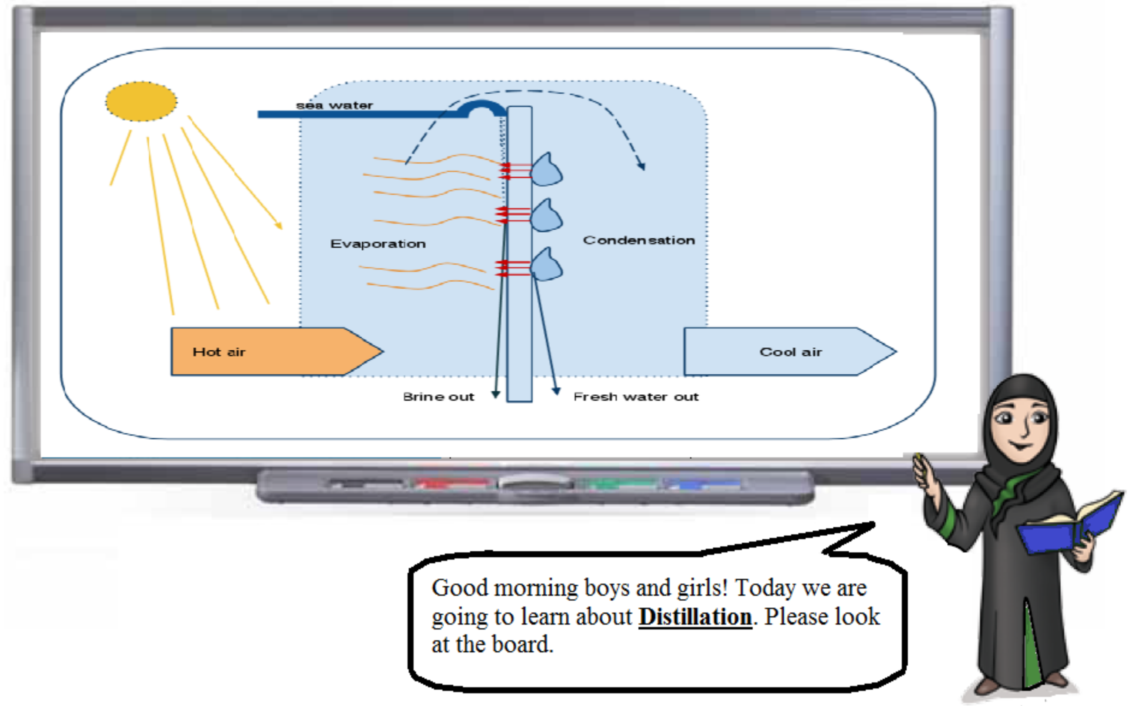

Figure 2. Representative sample of Scientific English text reference to a visual illustration a more modern use with technology.

As shown in Table 5, mean scores for the quality of captions ranged between 1 (no caption) and 2 (identifies graphic content, but does not connect with text). In a lesson about elements, for example, there is an image of pieces of various types of metal (similar to the image in Figure 3). The caption defined this picture as *elements* without providing any further explanation as to how this image represented the concept.

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Figure 3. Representative example of graphic identified as "elements".

With respect to the semantic relation between text and graphic, very few graphics were only *decorative* (7%) while 93% of analyzed graphics supporting or adding to content knowledge development (Table 6). The greatest proportion (58%) was *representational* (i.e., showing a concrete example from the text), with *connection graphics* (30%) second (i.e., adding new information related to the text). Only 6% of the graphics were *organizational* (i.e., showing semantic relations, such as a flow chart).

Table 6. *Semantic Relationships*

	Decorative	**Representa-tional**	**Organiza-tional**	**Connec-tion**	**Mean Connection Level Score**
SE, Grade 7	0.0%	55.2%	0.0%	44.8%	2.69 (0.6)
SE, Grade 8	0.0%	51.1%	9.7%	38.7%	2.42 (0.79)
SRR, Grade 7	12.8%	64.1%	5.1%	17.9%	1.86 (0.72)
SRR, Grade 8	15.8%	58.0%	10.5%	15.8%	1.67 (0.95)

Note. Standard deviations displayed in parentheses next to mean.

Summary of Findings

The majority of the graphics were not explicitly referenced by the text nor did they contain captions to indicate purpose. Half of the graphics (50.8%) had captions and, within those, 75.8% identified the graphic, but provided no further details. Graphics

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were analyzed individually to explore whether graphics reinforced written content or presented extraneous information. Nearly all the graphics were on the same page spread as their corresponding text but most lacked text references or detailed captions. The types of individual graphics were analyzed to explore whether graphics supported both content-area knowledge and L2 vocabulary development. Most of the graphics were representational, such as a photograph of a marble that directly represented the example of a marble described in the text.

Discussion

The purpose of this study was to analyze how graphics are presented in texts designed for second language science readers and to make recommendations for improving their implementation. Our findings indicate that while the lack of meaningful captions and text references may hinder Qatari students' ability to fully benefit from graphics, the representational nature of the graphics may support second language acquisition.

According to the researchers who developed the GAP analysis (Slough et al., 2010), rather than just representing the text, graphics ideally add to and extend the reader's understanding of the text. The representation of the text through graphics, however, provides the scaffolding necessary for ELLs to develop vocabulary and content knowledge. Therefore, representational graphics could enhance vocabulary and language learning, and this should be considered a strength of the graphics and texts.

Because the graphics were largely representational in nature, a well designed graphic should allow the reader to make the connection between a word in the text and the visual beside it; yet, if a student is unfamiliar with a vocabulary word or series of words, having a picture without any caption or reference does not promote understanding. Returning to the opening example of the image of a car with the hood up (Figure 1) illustrates this point. Readers who are unsure what part of the car is the engine could easily be misguided by this graphic. *Engine* could refer to the entire apparatus under the hood, or it could be the word for a specific part, such as a *tank* or a *wire*.

Graphics can provide ELLs comprehensible input and make complex ideas more accessible (McCloskey, 2005). In order to help learners benefit from visual stimuli, visuals must be well integrated with the text, explicitly referenced by the text, and contain captions to indicate their purpose. In total, these findings indicate that, at present, the graphics within these select ELL curriculum materials are not designed in a way that support transmediation.

Additionally, the use of visuals in the analyzed texts may actually hinder ELLs' reading comprehension of scientific material. Research has indicated that a graphic's utility depends on the target audience (e.g., Hannus & Hyönä, 1999), and the content of some captions may actually confuse second language students. For instance, while the instructional purpose of Figure 3 may be apparent to a native speaker – *metals are made up of different elements* – it would be plausible for an ELL to misunderstand the

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graphic's intention and learn to use the word *element* in place of *metal*, or to miss the connection entirely. Further, some of the detailed captions present could be more distracting than useful. In a lesson about the discovery of cells, there is a picture of a microscope and information describing the eleventh century use of glass lenses. The text does not directly discuss this history nor is such knowledge required for the students to complete the corresponding lesson activities. While the information on the early use of glass lenses may be interesting and engaging for students, an ELL trying to understand the connection between the caption and text content could become confused.

Recommendations for ELL Text Selection

When selecting textbooks for a course, instructors can easily become overwhelmed by the sheer number of options. Evaluating graphics can be a quick preliminary step to narrow down selection. One way of avoiding the kinds of limitations found in the Qatari texts is to incorporate graphics evaluation into the textbook selection process using a rubric such as the one shown (Figure 4). This rubric provides a cursory evaluation system of graphics, aimed at selecting textbooks most suited for ELLs.

	Textbook A: ________________			**Textbook B: ______________**		
	Graphic A	Graphic B	Graphic C	Graphic A	Graphic B	Graphic C
Page #:	_______	_______	_______	_______	_______	_______
Does the graphic model part or all of a system?						
Is the graphic near relevant textual content?						
Does the text reference the graphic?						
Does the graphic have descriptive captions?						
Would the graphic/ captions contribute to content knowledge without confusing the reader?						
Totals:	Yes responses: _______ / 15			Yes responses: _______ / 15		

Figure 4. Rubric for evaluating graphics in textbooks which can be used during the textbook selection process.

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Textbook evaluators first randomly select a graphic from the beginning, middle, and end of each text. Next, evaluators examine the chosen graphics, marking either *yes* or *no* to answer the questions for each graphic. Finally, a count of *yes* responses for each text allows for a comparison of the overall graphic quality. While certainly not a comprehensive system for evaluating textbooks, this rubric provides a method to quantitatively consider graphics as part of the textbook selection process and compare between texts.

Recommendations for Classroom Educators

While ideally, instructors have the liberty to use textbooks most suited to their students' needs, this scenario is uncommon. When presented with less-than perfect textbooks, instructors can make minor modifications so that visuals will support language acquisition. Increasing instructor awareness of problematic aspects of graphics can overcome many potential weaknesses and increase the value of graphics through critical classroom discussion.

One of the greatest differences between reading strategies utilized by students and field experts is how the two groups view the text. While those in middle and high school will likely perceive the textbook to be an authoritative source of information, experts understand that a text is just one contribution to a larger conversation (Haas & Flower, 1988). Teaching students to engage with the text by questioning the author and determining purpose can facilitate classroom conversation and critically engage students with the text. Teachers may utilize rhetorical reading strategies (Warren, 2012), where students are asked to consider the author's purpose in including the graphic. Using this strategy, the discussion of a potentially problematic graphic, such as the image of metal pieces in Figure 3, could serve as a learning experience for students to think more critically across the curriculum.

Many of the problems associated with poor graphics relate to their relationship with relevant text. When graphics are either (a) not located near relevant text, (b) not referenced by the text, or (c) not connected to text through captions, a well-informed teacher can address potential problems. If time permits, teacher-created captions could be added to the text before presenting the lesson to students. As students become more informed users of graphics, teachers can also challenge them to rewrite or repair poorly written captions.

Conclusion

Although visuals have long been valued as an asset to ELLs' instruction (e.g., Cunningsworth, 1984), teachers need to consider how well these visuals support both second language and curriculum development. We assert that individuals choosing textbooks and course materials for ELLs need to evaluate and consider the quality of visuals as part of the selection process, particularly when teaching technical classes, such as science.

While focused on one country, the findings and implications are applicable to those who teach ELLs worldwide. Graphics have the potential to support ELLs'

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language acquisition in a robust manner; however, without purposeful implementation, they may actually become a hindrance rather than a support. As textbook publishers, curriculum developers, and instructors become more aware of the possible pitfalls of these images, they can insist on the kind of support that restores the graphic's purpose. In this manner, graphics can help ELLs develop content, language, and critical thinking skills simultaneously.

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